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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
10/602,323	06/24/2003	Kie Y. Ahn	1303.101US1	9045

21186 7590 06/06/2005

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EXAMINER
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TOLEDO, FERNANDO L

ART UNIT	PAPER NUMBER
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2823

DATE MAILED: 06/06/2005

Please find below and/or attached an Office communication concerning this application or proceeding.

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<b>Office Action Summary</b>	<b>Application No.</b> 10/602,323	<b>Applicant(s)</b> AHN ET AL	
	<b>Examiner</b> Fernando L. Toledo	<b>Art Unit</b> 2823	

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

**Period for Reply**

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

**Status**

- 1) ☒ Responsive to communication(s) filed on 25 August 2004.
- 2a) ☐ This action is FINAL.                      2b) ☒ This action is non-final.
- 3) ☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

**Disposition of Claims**

- 4) ☒ Claim(s) 1-41 and 69-72 is/are pending in the application.
- 4a) Of the above claim(s) 16-41 is/are withdrawn from consideration.
- 5) ☐ Claim(s) \_\_\_\_\_ is/are allowed.
- 6) ☒ Claim(s) 1-9, 11-15 and 69-72 is/are rejected.
- 7) ☒ Claim(s) 10 is/are objected to.
- 8) ☐ Claim(s) \_\_\_\_\_ are subject to restriction and/or election requirement.

**Application Papers**

- 9) ☐ The specification is objected to by the Examiner.
- 10) ☒ The drawing(s) filed on 24 June 2003 is/are: a) ☒ accepted or b) ☐ objected to by the Examiner.  
Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).  
Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).
- 11) ☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

**Priority under 35 U.S.C. § 119**

- 12) ☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).
- a) ☐ All    b) ☐ Some \* c) ☐ None of:
1. ☐ Certified copies of the priority documents have been received.
2. ☐ Certified copies of the priority documents have been received in Application No. \_\_\_\_\_.
3. ☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).
- \* See the attached detailed Office action for a list of the certified copies not received.

**Attachment(s)**

- |  |   |
|--|---|
| 1) <input type="checkbox"/> Notice of References Cited (PTO-892)   | 4) <input type="checkbox"/> Interview Summary (PTO-413)<br>Paper No(s)/Mail Date. _____ |
| 2) <input type="checkbox"/> Notice of Draftsperson's Patent Drawing Review (PTO-948)   | 5) <input type="checkbox"/> Notice of Informal Patent Application (PTO-152)             |
| 3) <input checked="" type="checkbox"/> Information Disclosure Statement(s) (PTO-1449 or PTO/SB/08)<br>Paper No(s)/Mail Date <u>4/12/04, 8/25/04, 3/14/05</u> | 6) <input type="checkbox"/> Other: _____  |

## DETAILED ACTION

### *Election/Restrictions*

1. Claims 16 – 41 are withdrawn from further consideration pursuant to 37 CFR 1.142(b) as being drawn to a nonelected invention, there being no allowable generic or linking claim. Election was made **without** traverse in the reply filed on 25 August 2004. Claims 42 – 68 have been cancelled.
2. Applicant's election without traverse of claims 1 – 15 in the reply filed on 25 August 2004 is acknowledged.

### *Claim Rejections - 35 USC § 103*

3. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

(a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negated by the manner in which the invention was made.

4. Claims 1 – 9 and 69 are rejected under 35 U.S.C. 103(a) as being unpatentable over Girardie (US Patent Application Publication US 2003/0124794 A1) in view of Blocher, Jr. et al. (Deposition Technologies for Films and Coatings).

In re claim 1, Girardie, in the US Patent Application Publication US 2003/0124794 A1, figures 1 – 14 and related text discloses forming a layer 6 of hafnium oxide by atomic layer deposition; and forming a layer 6 of a lanthanide oxide by atomic layer deposition, wherein the layer of hafnium oxide is in contact with the layer of lanthanide oxide.

Girardie does not disclose wherein the layer of a lanthanide oxide is formed by electron beam evaporation.

However, Blocher, Jr. in the textbook Deposition Technologies for Films and Coatings discloses that electron beam evaporation offers a wide range of control over evaporation rates (page 102).

It would have been obvious to one of ordinary skill in the art at the time the invention was made to form the lanthanide oxide of Girardie by electron beam evaporation instead of ALD, since, as taught by Blocher, Jr., electron beam evaporation offers a wide range of control over evaporation rates.

5. In re claim 2, Girardie discloses forming the layer of hafnium oxide on a substrate and forming the layer of lanthanide oxide on the layer of hafnium oxide (Paragraphs 009 and 0037).

6. In re claim 3, Girardie discloses forming the layer of lanthanide oxide on a substrate and forming the layer of hafnium oxide on the layer of lanthanide oxide (Paragraphs 009 and 0037).

7. In re claim 4, Girardie discloses controlling the forming of the layer of hafnium oxide and the forming of the layer of the lanthanide oxide to form a lanthanide oxide/hafnium oxide nanolaminate (Paragraph 0037).

8. In re claim 5, Girardie discloses wherein the method further includes limiting a combined thickness of lanthanide oxide layers to between about 2 nanometers and about 10 nanometers (Paragraph 0037).

9. In re claim 6, Girardie discloses wherein the method further includes limiting a combined thickness of hafnium oxide layers to a thickness between about 2 nanometers and about 10 nanometers (Paragraph 0037).

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10. In re claim 7, Girardie discloses wherein the method further includes forming multiple layers of lanthanide oxide, each layer of lanthanide oxide limited to a thickness between about 2 nanometers and about 10 nanometers (Paragraph 0037).

11. In re claim 8, Girardie discloses wherein forming a layer of a lanthanide oxide includes forming an oxide selected from  $\text{Pr}_2\text{O}_3$ ,  $\text{Nd}_2\text{O}_3$ ,  $\text{Sm}_2\text{O}_3$ ,  $\text{Gd}_2\text{O}_3$ , and  $\text{Dy}_2\text{O}_3$  (Paragraph 0019).

12. In re claim 9, Girardie discloses wherein the method further includes maintaining the substrate temperature at a temperature ranging less than  $400^\circ\text{C}$  (Paragraph 0008).

It would have been obvious to one having ordinary skill in the art at the time the invention was made to have the temperature range from  $100^\circ\text{C}$  to about  $150^\circ\text{C}$ , since it has been held that where the general conditions of a claim are disclosed in the prior art, discovering the optimum or workable ranges involves only routine skill in the art. *In re Aller*, 105 USPQ 233. Note that the specification contains no disclosure of either the critical nature of the claimed temperature range or any unexpected results arising therefrom. Where patentability is said to be based upon particular chosen temperature range or upon another variable recited in a claim, the Applicant must show that the chosen temperature range is critical. *In re Woodruf*, 919 F.2d 1575, 1578, 16 USPQ2d 1934, 1936 (Fed. Cir. 1990).

13. In re claim 69, Girardie discloses forming the dielectric layer in a capacitor (Figure 13).

14. Claims 11 – 15 are rejected under 35 U.S.C. 103(a) as being unpatentable over Girardie in view of Kukli et al. (Properties of hafnium oxide films grown by atomic layer deposition from hafnium tetraiodide and oxygen) and in view of Blocher, Jr. et al.

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In re claim 11, Girardie discloses forming a layer of hafnium oxide 6 on a substrate by atomic layer deposition; and forming a layer of lanthanide oxide 6 on the layer of hafnium oxide by atomic layer deposition (Paragraphs 0019 and 0037).

Girardie does not disclose wherein the layer of a lanthanide oxide is formed by electron beam evaporation.

However, Blocher, Jr. discloses that electron beam evaporation offers a wide range of control over evaporation rates (page 102).

It would have been obvious to one of ordinary skill in the art at the time the invention was made to form the lanthanide oxide of Girardie by electron beam evaporation instead of ALD, since, as taught by Blocher, Jr., electron beam evaporation offers a wide range of control over evaporation rates.

Girardie in view of Blocher, Jr. does not disclose wherein the hafnium oxide is formed using  $\text{HfI}_4$ .

However, Kukli, in the article "Properties of hafnium oxide films grown by atomic layer deposition from hafnium tetraiodide and oxygen" discloses that  $\text{HfI}_4$  avoids residual carbon contamination in MOS devices (second column, page 5698).

It would have been obvious to one of ordinary skill in the art at the time the invention was made to form the hafnium oxide by ALD using  $\text{HfI}_4$  as a precursor in the invention of Girardie in view of Blocher, Jr., since, as taught by Kukli,  $\text{HfI}_4$  avoids residual carbon contamination.

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15. In re claim 12, Girardie discloses wherein the method further includes controlling the forming of the layer of hafnium oxide and the forming of the layer of the lanthanide oxide to form a lanthanide oxide/hafnium oxide nanolaminate (Paragraphs 0019 and 0037).

16. In re claim 13, Girardie discloses wherein the method further includes limiting the combined thickness of lanthanide oxide layers to a thickness between about 2 nanometers and about 10 nanometers (Paragraph 0037).

17. In re claim 14, Girardie discloses wherein forming a layer of a lanthanide oxide includes forming an oxide selected from  $\text{Pr}_2\text{O}_3$ ,  $\text{Nd}_2\text{O}_3$ ,  $\text{Sm}_2\text{O}_3$ ,  $\text{Gd}_2\text{O}_3$ , and  $\text{Dy}_2\text{O}_3$  (Paragraph 0019).

18. In re claim 15, Girardie discloses wherein the method further includes maintaining the substrate temperature at a temperature ranging less than  $400^\circ\text{C}$  (Paragraph 0008).

It would have been obvious to one having ordinary skill in the art at the time the invention was made to have the temperature range from  $100^\circ\text{C}$  to about  $150^\circ\text{C}$ , since it has been held that where the general conditions of a claim are disclosed in the prior art, discovering the optimum or workable ranges involves only routine skill in the art. *In re Aller*, 105 USPQ 233. Note that the specification contains no disclosure of either the critical nature of the claimed temperature range or any unexpected results arising therefrom. Where patentability is said to be based upon particular chosen temperature range or upon another variable recited in a claim, the Applicant must show that the chosen temperature range is critical. *In re Woodruff*, 919 F.2d 1575, 1578, 16 USPQ2d 1934, 1936 (Fed. Cir. 1990).

19. Claims 1 and 70 – 72 are rejected under 35 U.S.C. 103(a) as being unpatentable over Ahn et al. (US Patent Application Publication US 2002/0192974 A1) in view of Girardie.

In re claim 1, Ahn discloses forming a layer of hafnium oxide 40 by PVD; and forming a layer of lanthanide oxide 50 by electron beam evaporation, wherein the layer of hafnium oxide is in contact with the layer of lanthanide oxide (Paragraphs 0025, 0027 and 0028).

Ahn does not show, wherein the hafnium oxide layer is formed by ALD.

However, Girardie discloses that ALD makes it possible to control the thickness of the layers, which makes it possible to guarantee good homogeneity of the thickness over the entire surface of the dielectric layer, and therefore to avoid sources of defects (Paragraph 0020).

It would have been obvious to one of ordinary skill in the art at the time the invention was made to form the hafnium oxide layer of Ahn by ALD, since, as taught by Girardie, ALD makes it possible to control the thickness of the layers, which makes it possible to guarantee good homogeneity of the thickness over the entire surface of the dielectric layer, and therefore to avoid sources of defects.

20. In re claim 70, Ahn discloses wherein forming the dielectric layer includes forming the dielectric layer on a body region between a source and a drain in a transistor (Figure 3).

21. In re claim 71, Ahn discloses wherein forming the dielectric layer includes forming the dielectric layer on a body region between a source and drain in a transistor in a memory (Paragraph 0035).

22. In re claim 72, Ahn discloses wherein forming the dielectric layer includes forming the dielectric layer at least one of a controller and a device coupled to the controller in an electronic system (Paragraph 0035).



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*Claim Objections*

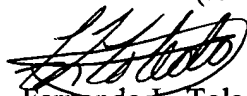
23. Claim 10 is objected to as being dependent upon a rejected base claim, but would be allowable if rewritten in independent form including all of the limitations of the base claim and any intervening claims.

*Conclusion*

Any inquiry concerning this communication or earlier communications from the examiner should be directed to Fernando L. Toledo whose telephone number is 571-272-1867. The examiner can normally be reached on Mon-Thu 7am to 5:30pm.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Olik Chaudhuri can be reached on 571-272-1855. The fax phone number for the organization where this application or proceeding is assigned is 703-872-9306.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see <http://pair-direct.uspto.gov>. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free).



Fernando L. Toledo  
Examiner  
Art Unit 2823